278 C. 2

① Minnesota [redacted]
[redacted] Ext. Serv. ②
Ext. Bulletin 278 1963
③

MN2000 EB 278 Rev. 1963 c.2

EXTENSION BULLETIN 278 **JUNE 1963**

Soils of Minnesota

H. F. ARNEMAN

The types of soil found on any farm or forest largely determine the type of farming, the crops to be grown, and the tree species that will grow most rapidly. Anyone concerned with land management should know the kind of soil he works with and what to expect from it.

The map in this bulletin does not attempt to show all soil differences. Rather it shows the various areas where soils are related to one another or where entirely different soils occur in such close association that they cannot be separated on a map of this scale.

These soil groups are called soil associations and the map is called a soil association map. A soil association is nothing more than a group of soils that are closely associated geographically with one another. The soil association map is based upon information collected from various sources.

Relationship of Soils to Environment

The type of soil found in any one place reflects the combined action of the factors of soil formation: (1) soil parent material, (2) climate, (3) vegetation, (4) topography, and (5) time.

Parent Material

The parent materials of the soils of Minnesota were primarily deposited by the action of glaciers during the Ice Age. Glaciers invaded Minnesota from both a northwesterly direction (Kewatin Glacial Center) and a northeasterly direction (Patrician Glacial Center). The advancing glaciers originating in the Kewatin Center passed over limestone deposits in southern Canada and scooped up some of these materials; for this reason the material deposited by these glaciers was usually calcareous (calcium-containing).

Glaciers emanating from the Patrician Center passed over the bedrock deposits of the Laurentian Shield area of northeastern Minnesota and southern Ontario. The material deposited by the glaciers of the Patrician Center is usually noncalcareous because of the lack of limestone in the area traversed by the glaciers. Materials deposited directly by glacial ice are known as till. Till is a nonstratified heterogenous mixture of mineral materials closely related to the source material over which the glacier passed.

Considerable quantities of running water were expelled in front of the melting glacier. This running water deposited well sorted outwash materials ranging in texture from gravel to sand. The compositon of outwash is dependent upon the source material where the water originates and over which the water passes.

Texture of the outwash material depends on the rate of flow of the water. Outwash is found on stream terraces such as those along the Minnesota and Mississippi rivers and on outwash flats where considerable water action took place in glacial times but no large present day streams remain.

In southeastern and southwestern Minnesota there are extensive areas of silty parent materials which were deposited by wind. Immediately following the glacial periods there was a time when no vegetation grew on the area. During this time the wind could blow about and deposit materials. These silty wind-deposited materials are known as loess.

In northwestern Minnesota, in the area known as the Red River Valley, large areas are covered with glacial lake deposits. In glacial times the entire Red River Valley was a large glacial lake known as Lake Agassiz. The parent materials deposited in this old lake bed vary from sandy gravelly material along the old beach lines to silty and clayey materials near the present Red River. Several other glacial lakes of lesser extent, such as glacial Lake Duluth and glacial Lake Minnesota, once were found in Minnesota. The materials deposited in glacial lakes are known as lacustrine deposits.

The preceding materials form a complex land pattern in Minnesota and provide the parent materials from which Minnesota soils, as we now see them, have developed.

Climate

The second factor important in soil formation is climate. The chemical and physical alteration (weathering) of parent material during soil development is closely related to climate. Both temperature and moisture are important. It is not enough to consider only the average temperature and rainfall, it is also important to consider such things as extremes in temperature and rainfall.

Chemical weathering in soils is mostly confined to the time of the year when the temperature of the soil is above 60° F. Below this temperature chemical changes occur slowly. Total rainfall is not as important in itself as is the effective rainfall. Considerable moisture is lost from soils by evaporation and transpiration. In cool climates both of these are lower than in warm areas. Northern Minnesota with 22 inches of precipitation has more effective moisture for plant growth due to the cool temperatures than southern Minnesota with 28 inches of precipitation. Moisture and temperature are therefore very important in the breakdown of minerals and rocks in the parent materials.

Native Vegetation

Native vegetation has had a profound effect upon the characteristics of soils as we now see them. Native vegetation can be divided into two categories, (1) forest and (2) prairie. The dark color of surface soils is closely related to organic matter content supplied by shallow rooted plants with extensive root systems. Trees are the most common forest vegetation plants. The trees are characterized by having a few large roots instead of the fibrous root system of prairie grasses.

Organic matter added to the surface in forested areas in the form of leaf or needle fall often forms a mat at the surface and does not become incorporated with the mineral matter. Thus, with a low content of organic matter incorpo-

---

H. F. Arneman is associate professor, Department of Soil Science. This bulletin would not have been possible without information supplied by Alex S. Robertson and W. W. Anderson, and the soil survey staff of the U. S. Department of Agriculture Soil Conservation Service. The author also is indebted to R. S. Farnham and R. H. Rust, his coworkers in the Department of Soil Science, for their guidance and assistance in preparing the map and manuscript of this bulletin.

gricultural Extension Service ● University of Minnesota ● U. S. Department of Agriculture

rated with the surface soils of the forested areas, a light colored bleached surface soil results. In prairie areas where many of the fibrous roots decay each year the surface soil is well supplied with organic matter and the result is a dark color. Dark colored surfaces are characteristic of prairie areas. In the so called "Big Woods" area of south-central Minnesota the soils are dark colored resembling a prairie soil. In this area it is thought that trees invaded the prairie but have not been growing in the area for a long enough period to allow the organic matter to be leached out of the surface soil by percolating waters.

There are definite interactions between climate and vegetation. Climate is all-important in determining the native vegetation of an area. Prairie vegetation results when evaporation from a free water surface is greater than rainfall. For that reason, in northern Minnesota, where the climate is cool and evaporation less, forest vegetation will result with an annual rainfall of only 24 inches. In southern Minnesota grassland vegetation will result with the same rainfall.

Just as climate can affect vegetation, vegetation can have an effect on climate. In a forest area the soil temperature is cooler than in the same vicinity with grassland vegetation.

Topography

Topography (the lay of the land) is another factor of soil formation. Its effect on soil formation is mainly due to its effect on climate and thus on vegetation. Slope has a great bearing on the amount of runoff water in an area and thus affects the water available for plants. Plants therefore grow more profusely on level land. The direction (aspect) that the slope faces is also important. A south-facing slope is warmer and drier than a north slope in the same locality. A typical place to study the effects of direction of slope is along the Minnesota River bluffs west of Mankato. The south-facing slopes in this area are too warm and dry for good tree growth while the north-facing slopes have timber on them as far west as Redwood Falls.

Time

Soils formed from older parent materials are more highly developed than soils formed from younger materials because of the greater length of time over which the other factors acted.

Soil Associations of Minnesota

The soils of Minnesota have been divided into 57 different associations. These associations have been grouped into 15 broad soil groups. Each is shown on the map by its own distinctive color.

Silty Forest and Prairie Soils of South-Eastern Minnesota

1. **Fayette-Dubuque.** This is a sloping to steep area. These light colored soils have good internal drainage and good to rapid surface drainage depending on slope. Fayette silt loam is formed from silty thick loess and Dubuque silt loam is formed from loess overlying limestone or limestone residum within 42 inches of the surface. Erosion control is a major problem on these soils. Dairy and general livestock farming predominate. Prominent crops are corn, oats, and alfalfa.

2. **Fayette-Dubuque-Rough Land.** This area is much the same as area 1 except for a much greater proportion of steeply sloping and rough broken areas. Rock outcrops are common on many of the slopes. Erosion is a major problem. The rough land areas are used for woodland while the more level areas are used as they are in area 1.

3. **Fayette-Tama.** This is a gently sloping to strongly sloping area. The soils have formed from silty loess. The light colored Fayette soils developed under the influence of forest vegetation, and occupy the more sloping areas. The dark colored Tama prairie soils occupy the more level divides between the drainageways. Soil erosion control is a major problem. These productive soils are used for dairy and general livestock farming. Major crops are corn, oats, and alfalfa.

4. **Tama-Downs.** This is a gently sloping to sloping area where the soils have formed from silty loess. Dark colored Tama formed under prairie vegetation, and moderately dark colored Downs developed where forests encroached upon the prairies. Erosion control is the major management problem. These highly productive soils are used for dairying and general livestock farming. Corn, soybeans, oats, and alfalfa are important crops.

Medium Textured Prairie and Prairie Border Soils of Southeastern Minnesota

5. **Kasson-Skyberg-Floyd.** This is a nearly level to gently sloping area. These soils have developed in a thin loess mantle overlying firm medium textured leached glacial till. Kasson is moderately dark colored and moderately well drained. Skyberg is moderately dark colored and somewhat poorly drained. Floyd is dark colored and poorly drained and usually occurs adjacent to the upland drainageways. Major management problems are drainage and fertility maintenance. Lime is usually necessary for legume production. Cash grain and livestock farming predominate. Corn, soybeans, oats, and red clover are prominent crops.

6. **Ostrander-Kenyon-Floyd.** This is a nearly level to sloping area. These dark colored soils are well to poorly drained and formed in a thin loess mantle overlying firm medium textured leached glacial till. Ostrander is well drained and occurs on slopes. Kenyon is moderately well drained and is found on nearly level to undulating convex positions. Floyd is poorly drained and occurs in upland drainageways and level areas. Soils that have not been limed are usually acid. Major management problems are erosion control on the Ostrander and drainage on the Floyd. Cash grain and livestock farming predominate. Principal crops are corn, oats, soybeans, and alfalfa or red clover.

7. **Racine-Ostrander.** This is primarily a sloping region with some small nearly level areas. These well drained soils are formed in a thin loess mantle overlying leaching firm glacial till. Racine soils were formed where woods encroached on the prairie and are moderately dark colored. Ostrander is a dark colored prairie soil. Major management problems are erosion control and fertility maintenance. Cash grain and livestock farming predominate. Common crops are corn, oats, soybeans, and red clover or alfalfa.

Coarse to Fine Textured Forest Soils of East-Central Minnesota

8. **Dalbo-Brickton.** This is a level to undulating area. These light colored soils have formed from calcareous medium to fine textured lacustrine deposits. Dalbo silt loam is well to moderately well drained and is undulating. Brickton silty clay loam is somewhat poorly to poorly drained and is level. Major management problems are drainage and fertility maintenance. This is a general livestock and dairy type of farming area. Prominent crops are corn, soybeans, oats, and legume hay.

9. **Hayden.** This is a gently rolling to strongly rolling area. This light colored soil has formed from calcareous loam or

clay loam glacial till. Hayden is a well drained soil with a major erosion control problem. Poorly drained depressions in the area are occupied by the dark colored Bluffton soils or peat and muck. Major land uses are dairy farming and urban development. Major crops are legume hay, pasture, corn, and oats.

10. Hayden-Burnsville. This is a gently rolling to strongly rolling area. Hayden is light colored, well drained, and has formed from medium textured calcareous glacial till. Burnsville is moderately dark colored, excessively drained, and has formed from calcareous sandy and gravelly glacial drift. Burnsville soils are somewhat droughty. Erosion control is a major problem. Dairy farming and urban development predominate. When farmed principal crops are legume hay and pasture, oats, and corn.

Medium to Fine Textured Prairie Border Soils of Central Minnesota

11. Hayden - Kilkenny - Lester. This is a gently rolling to strongly rolling area. The well drained light colored Hayden loam and moderately dark colored Lester loam have formed from medium textured calcareous glacial till. The well drained moderately dark colored Kilkenny loam has formed from fine textured calcareous glacial till. Erosion is a major problem. Principal types of farming are dairy and general livestock. Major crops are corn, oats, and alfalfa.

12. Lester-LeSueur-Glencoe. This is a gently rolling area. These soils have formed from medium textured calcareous glacial till of Wisconsin age. Lester loam is moderately dark colored, well drained, and occurs on slopes. LeSueur is dark colored, moderately well drained, and occurs on nearly level areas. Glencoe clay loam is dark colored, very poorly drained, and occurs in wet depressions. Erosion is a major problem on Lester and drainage is needed on Glencoe. General livestock and dairy farming predominate. Common crops are corn, oats, and alfalfa.

Medium to Fine Textured Prairie Soils of South-Central Minnesota

13. Clarion-Nicollet-Webster. These are level to gently rolling areas. They are dark colored soils formed from calcareous loam till of Wisconsin age. Clarion loam is well drained, slightly acid, and occurs on slopes. Nicollet loam is moderately well drained and occupies nearly level areas. Webster clay loam is poorly drained and occurs in level areas. Soils formed from glacial outwash (Wadena, Hubbard) are common along streams. The margins of many saucerlike depressions are calcareous. Most level areas have been drained by tile and ditches. Erosion may be a problem on Clarion areas. Cash grain and livestock farming predominate. Prominent crops are corn, soybeans, oats, and alfalfa.

14. Clarion-Storden. These are rolling to hilly areas. These soils have formed from medium textured calcareous glacial till. Clarion loam is well drained, dark colored, and occurs on the lesser slopes in this area. Storden loam has excessive surface runoff, the dark surface is usually shallow, and subsoil is often exposed in plowing. Small knobs of gravelly Estherville soils often occur in the area. The major management problem is erosion control. Cash grain and livestock farming predominate. Common crops are corn, oats, and alfalfa.

15. Ihlen-Rock Outcrop. This area resembles area 14, Clarion-Storden, except that quarzite bedrock is near the surface and outcrops frequently. Where the outcrops occur the soils are used primarily for permanent pasture. Where the rock is far enough below the surface so as not to interfere with cultivation, the soils are managed the same as area 14.

16. Truman-Marna. This is a level to undulating area. These dark colored soils were formed from calcareous silty and clayey lacustrine or windblown deposits. Truman silt loam is well drained and occurs on the gentle slopes. Marna silty clay loam is poorly drained, fine textured, and occurs on the level areas. Erosion control is a problem on some Truman soils but the major problem of the area is drainage. This is a cash grain or livestock-feeding area. Major crops are corn, soybeans, and oats.

Silty Prairie Soils of Southwestern Minnesota

17. Ihlen-Moody. This is a gently sloping to sloping area. These dark colored soils have developed in calcareous silty loess overlying quartzite bedrock in some places. Ihlen silt loam is well drained and slightly acid. Quartzite bedrock is less than 42 inches below the surface. Moody silt loam is well drained and is developed from thick loess. Erosion is a problem on these soils. Cash grain and livestock feeding predominate. Prominent crops are corn, soybeans, and small grain.

18. Kranzburg-Vienna-Moody. This is a gently sloping to sloping area with relatively long slopes. These dark colored well drained soils are developed from both calcareous till and loess. Kranzburg silt loam has formed in thin loess overlying glacial till, Vienna has formed from calcareous glacial till, and Moody silt loam has formed from thick silty loess. Erosion is the major management problem on these soils. Cash grain and livestock feeding predominate. Principal crops are corn, soybeans, and small grain.

19. Moody-Crofton. This is a gently sloping to sloping moderately dissected area. These dark colored soils have developed from calcareous silty loess. Moody silt loam is found on the gentle to moderate slopes and Crofton silt loam occurs on the steeper slopes. Water conservation and erosion control are major management problems. Cash grain and livestock farming predominate. Corn, oats, and hay are common crops.

Medium to Fine Textured Prairie and Prairie Border Soils of Western Minnesota

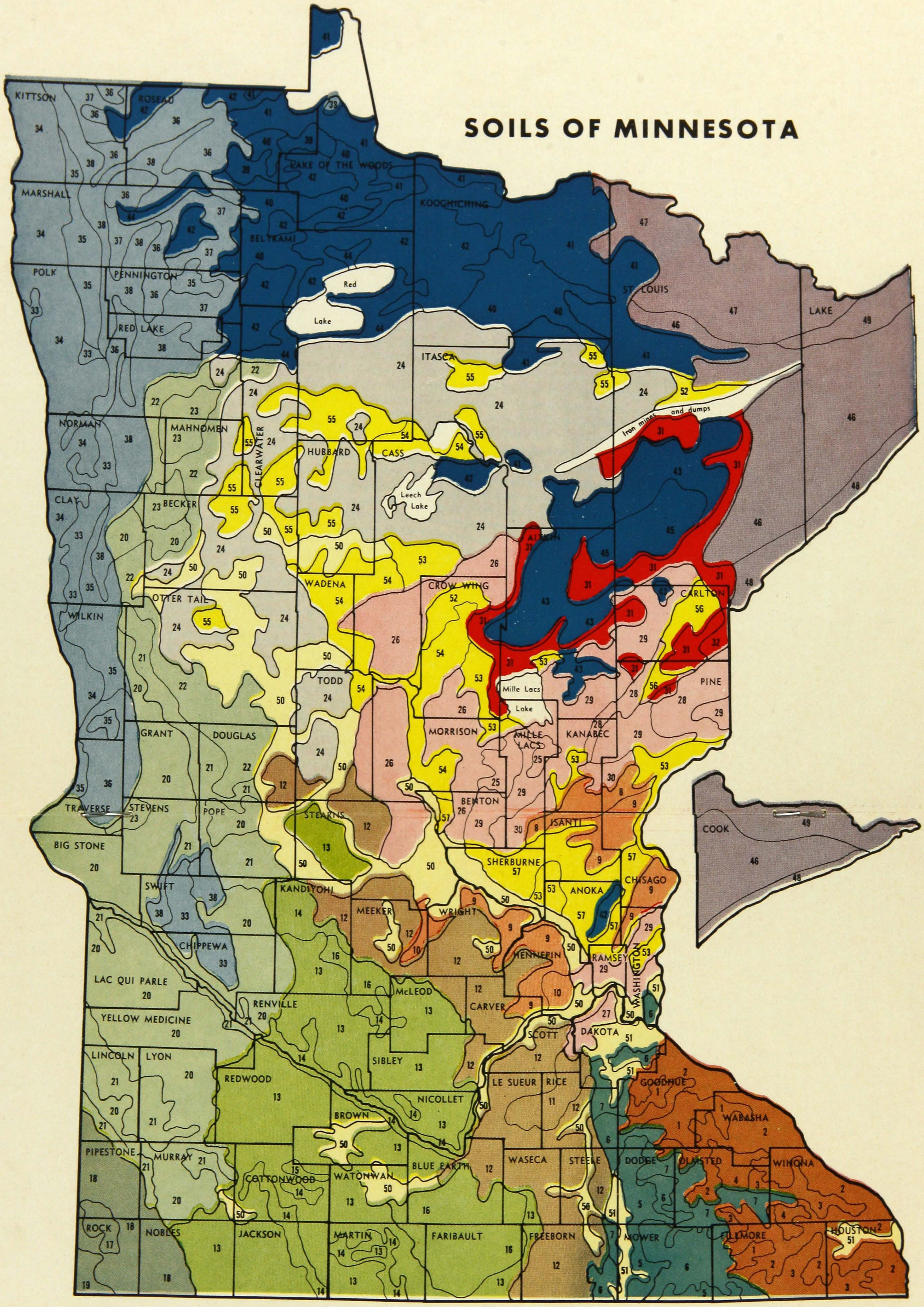
20. Barnes-Aastad-Flom. This is a nearly level to rolling area. These are dark colored soils formed from calcareous loam glacial till. Barnes loam is well drained and occurs on generally convex slope postions on the landscape. Aastad clay loam is moderately well drained and occurs in nearly level areas. Flom is poorly drained and occurs on the level areas. The margins of many saucerlike shallow depressions are calcareous at the surface. Erosion control on rolling areas and drainage of poorly drained areas are major management problems. Cash grain farming is the principal use. Corn, small grain, and soybeans are the main crops.

21. Barnes-Buse-Pierce. This is a gently rolling to hilly region. These dark colored soils have developed from calcareous loam glacial till, with some prominent areas of soils developed from calcareous gravel. Barnes is well drained and occurs on the lesser slopes in the area. Buse has excessive surface drainage, has a shallow surface, and when plowed the subsoil is often exposed. Pierce is a coarse textured soil developed from calcareous gravels occurring as knobs and ridges in the area. Erosion control and water conservation are major problems. General farming predominates. Common crops are corn and small grain on the less sloping areas, and pasture on the hilly areas.

22. Waukon-Barnes. This is an undulating to rolling area. These well drained dark colored soils formed from calcareous glacial till. Barnes developed under native prairie vegetation and Waukon developed where trees encroached on originally prairie vegetation. Cash grain farming predominates. Common crops are small grain, corn, and alfalfa.

23. Winger-McIntosh. This is a nearly level to undulating area. These dark colored soils have formed from calcareous lake-modified silty deposits overlying calcareous loam till. Winger silt loam is somewhat poorly drained and normally has a calcareous surface. McIntosh silt loam is moderately well drained with a neutral surface. Major management problems are drainage and fertility main-

SOILS OF MINNESOTA



Silty Forest and Prairie Soils of Southeastern Minnesota

▨
1 Fayette-Dubuque
2 Fayette-Dubuque-Roughland
3 Fayette-Tama
4 Tama-Downs

Medium Textured Prairie and Prairie Border Soils of Southeastern Minnesota

▨
5 Kasson-Skyberg-Floyd
6 Ostrander-Kenyon-Floyd
7 Racine-Ostrander

Coarse to Fine Textured Forest Soils of East-Central Minnesota

▨
8 Dalbo-Brickton
9 Hayden
10 Hayden-Burnsville

Medium to Fine Textured Prairie Border Soils of Central Minnesota

▨
11 Hayden-Kilkenny-Lester
12 Lester-LeSueur-Glencoe

Medium to Fine Textured Prairie Soils of South-Central Minnesota

▨
13 Clarion-Nicollet-Webster
14 Clarion-Storden
15 Ihlen-Rock Outcrop
16 Truman-Marna

Silty Prairie Soil of Southwestern Minnesota

▨
17 Ihlen-Moody
18 Kranzburg-Vienna-Moody
19 Moody-Crofton

Medium to Fine Textured Prairie and Prairie Border Soils of Western Minnesota

▨
20 Barnes-Aastad-Flom
21 Barnes-Buse-Pierce
22 Waukon-Barnes
23 Winger-McIntosh

Medium Textured Forest Soils of North-Central Minnesota

▨
24 Nebish-Rockwood

Coarse to Medium Textured Forest Soils of East-Central Minnesota

▨
25 Bock-Adolph-Peat
26 Flak-Brainerd-Nokay
27 Kingsley-Chetek
28 Milaca-Chetek
29 Milaca-Mora-Bock
30 Santiago-Freeon-Freer

Fine Textured Forest Soils of East-Central Minnesota

▨
31 Hibbing-Zim
32 Ontonagan-Bergland

Coarse to Fine Textured Prairie Soils and Organic Soils of Glacial Lake Plains

▨
33 Bearden-Glyndon
34 Fargo
35 Grimstad
36 Rocksbury-Fargo
37 Rocksbury-Peat
38 Ulen-Sioux-Grimstad

Coarse to Fine Textured Forest Soils and Organic Soils of Glacial Lake Plains

▨
39 Hiwood
40 Hiwood-Peat
41 Indus-Taylor-Peat
42 Peat
43 Peat-Swatara-Spooner
44 Redby-Peat
45 Spooner-Peat

Coarse to Fine Textured Forest Soils and Rock Outcrops of Northeastern Minnesota

▨
46 Ahmeek-Rock Outcrops
47 Cloquet-Taylor-Rock Outcrops
48 Ontonagan-Rock Outcrops
49 Rough Rock Outcrop Areas

Coarse to Medium Textured Prairie Soils Formed From Glacial Outwash

▨
50 Estherville-Wadena-Hubbard
51 Waukegan-Dakota

Coarse to Medium Textured Forest Soils Formed From Glacial Outwash

▨
52 Chetek-Menahga
53 Chetek-Onamia
54 Menahga
55 Menahga-Marquette
56 Omega-Cloquet
57 Zimmerman-Isanti-Peat

tenance. Cash grain farming predominates. Small grains are the most common crops.

Medium Textured Forest Soils of North-Central Minnesota

24. **Nebish-Rockwood.** This is an undulating to hilly area. These light colored well drained soils have developed from loam (Nebish) and sandy loam (Rockwood) calcareous buff-colored glacial till. Lakes and poorly drained mineral and organic soils occupy the level and depressional areas. The major land uses are forestry and general farming. There is considerable recreation development in the lake areas. Erosion control and organic matter maintenance are major problems on farms. Common tree species are aspen and white birch. Common farm crops are alfalfa and small grain.

Coarse to Medium Textured Forest Soils of East-Central Minnesota

25. **Bock-Adolph-Peat.** This is a nearly level area. These soils have formed from noncalcareous medium textured glacial till and organic deposits. Bock loam is somewhat poorly drained, moderately dark colored, and occurs on the convex slopes in the area. Adolph silt loam is a dark colored, very poorly drained depressional mineral soil. Peat soils are dark brown poorly drained organic soils. General livestock farming is common, with a preponderance of permanent pasture. Common crops are corn for silage, small grain, rotation pasture, and hay.

26. **Flak-Brainerd-Nokay.** This is a gently rolling area with moderately long slopes. These are light colored soils formed from a stony noncalcareous sandy loam glacial till. Flak is well drained, Brainerd moderately well drained and Nokay is somewhat poorly drained. Poorly drained depressions are found on the landscape. The soils of this association have a hardpan in them that often slows up water infiltration and hampers root development, especially on the deep-rooted legume crops. Major management problems are stone removal, erosion control, and drainage. Where farmed, dairy farming predominates; much of the area is now in second growth timber with aspen abundant. Common agricultural crops are corn for silage, small grain, and legume grass hay or pasture.

27. **Kingsley-Chetek.** This is a rolling to hilly area. These light colored well to excessively drained soils have developed from a slightly calcareous red glacial till (Kingsley) and from noncalcareous gravelly outwash (Chetek). Much of this area is being developed for urban use. Only scattered small areas are being used for agriculture. When farmed erosion control is a major problem.

28. **Milaca-Chetek.** This is a rolling to hilly area. These light colored well to excessively drained soils have developed from noncalcareous stony and sandy loam till (Milaca) and noncalcareous gravelly outwash (Chetek). Only scattered areas are used for agriculture. The major portion is covered with second growth aspen and oak trees. These are not particularly productive areas for either agriculture or timber.

29. **Milaca-Mora-Bock.** This is a gently rolling area with moderately long slopes. These light colored soils have formed from stony noncalcareous red sandy loam or sandy clay loam glacial till. Milaca is well drained, Mora moderately well, and Bock somewhat poorly drained. Small poorly drained depressions of either Adolph or peat soils dot the landscape. The subsoil often has a somewhat impermeable layer and this hampers the rate of water infiltration and the development of the roots of the deep-rooted legumes. Stoniness is a major management problem. Dairy farming is common in the area where farming occurs. Almost every farm has some acreage of woodland pasture. Common crops are corn for silage, small grain, and legume-grass hay or pasture.

30. **Santiago-Freeon-Freer.** This area resembles area 29. The major difference is that the soils have formed in a silt mantle overlying the compact red sandy loam till. Santiago is well drained, Freeon moderately well, and Freer poorly drained. These are better agricultural soils than the nonsilt cap soils (area 29). They are less stony and the farms have more land under cultivation.

Fine Textured Forest Soils of East-Central Minnesota

31. **Hibbing-Zim.** This is an undulating to strongly rolling area. These light colored soils have formed from weakly calcareous red clayey glacial till. Hibbing is well or moderately well drained and occurs on the more sloping areas. Zim is somewhat poorly drained and occupies the more level areas. Only scattered fields of this soil are used for farming. Where farming occurs small grain and legume hay are major crops. Much of the region has stands of aspen, birch, and fir trees. It is a good aspen area.

32. **Ontonagon-Berglund.** This is a nearly level to gently rolling area except where it is dissected by streams. These soils have formed from red weakly calcareous lacustrine clay. Ontonagon slit loam is light colored, moderately well drained, and is found on slopes. Berglund is poorly drained, has a dark colored surface, and occurs on the nearly level areas. Some areas are used for dairying and for growing horticultural crops, but much of the region is in second growth forest.

Coarse to Fine Textured Prairie and Organic Soils of Glacial Lake Plains

33. **Bearden-Glyndon.** This is a level area. These somewhat poorly drained soils with black surface have formed from lacustrine sediments ranging from silt loam (Bearden) to very fine sandy loam (Glyndon). The soils are normally calcareous throughout the profile. Surface drainage is a major problem. Cash grain crops are the principal farm enterprise. Comon crops are small grain, potatoes, sugar beets, and some corn in the southern portions.

34. **Fargo.** This is a level area. This poorly drained soil with a black surface has formed from calcareous lacustrine clay. This soil is neutral to calcareous at the surface. Surface drainage is a problem, especially in spring. Common crops in this cash grain farming region are small grain, potatoes, and sugar beets.

35. **Grimstad.** This is a nearly level area. This dark colored soil has formed from fine sands overlying loam and clay loam calcareous till and is moderately well drained. Poorly to very poorly drained soils belong to the Tanberg series. Wind erosion on the better drained areas and drainage on the poorly drained areas are major problems. Common crops are small grains, pastures, and some legume seeds.

36. **Rocksbury-Fargo.** This is a level area. These dark colored poorly drained soils have formed from calcareous loam or clay loam glacial till (Rocksbury) and calcareous lacustrine clay (Fargo). Major problems of management are the removal of excess water, especially during the spring months. Common crops in this cash grain farming area are small grains, legume seeds, and some potatoes or sugar beets.

37. **Rocksbury-Peat.** This is a level to depressional area. The dark colored poorly drained Rocksbury developed from calcareous loam glacial till is intermingled with very poorly drained areas of organic soils (peat). In some areas where the peat is shallow farmers have burned it off the land during the dry part of the season to lessen the frost hazard. The peat soils are not used extensively for agriculture. On the mineral soils common crops are small grains and legume grass seed production.

38. **Ulen-Sioux-Grimstad.** This is a level to undulating area. These are dark colored soils developed from a variety of calcareous materials. Ulen has developed from lacustrine fine and very fine sand and is well or moderately well drained. Sioux has developed from gravels on old

lake beach-ridges and is excessively drained. Grimstad has developed from fine sands overlying loam and clay loam till and is moderately well drained. Wind erosion control is a major problem in this area. Common crops in this cash grain area are small grain, potatoes, and legume seed production.

Coarse to Fine Textured Forest Soils and Organic Soils of Glacial Lake Plains

39. Hiwood. This is a nearly level area. This light colored well drained soil is formed from calcareous lacustrine fine sand. Only a small portion is used for agriculture. Droughtiness is a major problem. Many areas support stands of jack pine or aspen.

40. Hiwood-Peat. This is a nearly level to undulating area. It differs from area 39 in having a little more slope, with the occurrence of organic soils in most of the numerous depressions.

41. Indus-Taylor-Peat. This is a level to undulating area. The mineral soils in this area are light colored and have formed from calcareous lacustrine clay. Indus is somewhat poorly drained and Taylor is moderately well drained. The mineral soils are intermingled with areas of organic (peat) soils. The peat soils are not used widely for agriculture but produce some pulpwood and Christmas trees. Some of the mineral soils are used for agriculture. The major crops grown are legumes for seed and hay, and small grain. Taylor and Indus soils support good stands of aspen trees in many places; for this reason forestry is sometimes a major industry.

42. Peat. Peat soils are organic soils formed from partially decomposed plant remains. Some broad areas of peat soils are found in many of the old glacial lake basins in Minnesota. Frost is the major hazard in farming these soils. When they are used for agriculture, potatoes and vegetable crops are commonly grown. In some areas the peat is mined and marketed for horticultural peat; other areas produce some spruce pulpwood and Christmas trees.

43. Peat-Swatara-Spooner. This is a level area of organic peat soils with islands of mineral soils. The light colored mineral soils have formed from calcareous lacustrine fine sand (Swatara) and silt loam (Spooner). Swatara is well drained and Spooner poorly drained. Agriculture in the area is confined primarily to scattered areas of mineral soils. Peat is mined in some areas for horticultural peat and also is used for Christmas trees and pulpwood production. Where crops are grown, vegetable crops, small grains, and hay predominate.

44. Redby-Peat. This is a nearly level region. The peat soils are intermingled with somewhat poorly drained, high water table mineral soils (Redby). Redby loamy fine sand is light colored and has formed from calcareous lacustrine fine sand. Agriculture is unimportant in this area. Most of the mineral soils support a stand of timber, usually aspen. Jack pine is found on some sandy ridges.

45. Spooner-Peat. In this nearly level area the areas of peat soil are intermingled with a poorly drained light colored mineral soil formed from calcareous lacustrine silts. Agriculture is of only minor importance. Where it is practiced legume hay and seed are major crops. Aspen trees are common on the mineral soils, and black spruce and tamarack on the peat.

Coarse to Fine Textured Forest Soils and Rock Outcrops of Northeastern Minnesota

46. Ahmeek-Rock Outcrops. This is a rolling to hilly area. The Ahmeek soils are dark colored soils formed from a reddish brown noncalcareous sandy, stony glacial till. Rock outcrops of basic igneous rocks are common. There is no agriculture to speak of in this area. The Ahmeek soils support a good growth of aspen and white spruce, and wood production is quite important.

47. Cloquet-Taylor-Rock Outcrops. This is a gently rolling to hilly area, with many lakes. Rock outcrops are prominent on the landscape, but only make up about one-fourth of the land surface. Cloquet is a light colored soil formed from gravelly glacial drift. Taylor is a light colored soil developed from calcareous lacustrine clay. This is a nonagricultural area. Some timber is harvested for lumber and pulpwood. The two most common tree species are jack pine in the gravelly soils and aspen on the clayey soils.

48. Ontonagon-Rock Outcrop. This is a rolling to hilly area bordering along Lake Superior. The rock outcrops are mostly basic igneous rocks. The light colored Ontonagon soil is formed from weakly calcareous red lacustrine clays. Only scattered areas are used for agriculture. Hay production is the most common agricultural use. Much of the region supports a growth of aspen, spruce, or fir trees.

49. Rough Rock Outcrop Area. This area has a hilly, choppy topography. Some Ahmeek soils are present, but the region is primarily very stony and rocky and is covered by many bedrock outcrops. This is often referred to as the wilderness area of Minnesota. Many lakes of variable sizes and shapes are found in the area. Outdoor recreation such as canoeing and camping is the most common usage.

Coarse to Medium Textured Prairie Soils Formed from Glacial Outwash

50. Estherville-Wadena-Hubbard. This is primarily a nearly level area, but some scattered areas are rolling to hilly. These dark colored soils are well to excessively drained. The Estherville and Wadena soils have formed from moderately coarse to medium textured material overlying calcareous outwash gravel. In Estherville the gravel is within 18 inches of the surface. Wadena is deeper. Hubbard is formed from leached coarse and medium sand outwash. Droughtiness and wind erosion are major management problems. General farming usually is practiced and common crops are corn, oats, soybeans, and hay or pasture.

51. Waukegan-Dakota. This is a nearly level to rolling area. These are dark colored well drained soils. Waukegan formed from a silt loam material overlying leached outwash gravel at 32 to 48 inches below the surface. Dakota is formed from medium textured material overlying sandy leached outwash. These soils, especially the Dakota, are at times somewhat droughty because of the underlying gravel or sand. General farming predominates. Prominent crops are corn, oats, soybeans, and legume hay or pasture.

Coarse to Medium Textured Forest Soils Formed From Glacial Outwash

52. Chetek-Menahga. This is for the most part a nearly level area. Soils are light colored and droughty. Chetek is developed in sandy loam or loam material overlying noncalcareous outwash gravel within 18 inches of the surface. Menahga is formed from medium to coarse outwash sand. Droughtiness is a major problem in these soils. Only scattered areas are used for agriculture, much of the area is in woods. Jack pine is the major tree species and considerable amounts are harvested for pulpwood and lumber.

53. Chetek-Onamia. This is primarily a nearly level area. These light colored soils are formed in medium textured material overlying noncalcareous sand and gravel. In Chetek the gravel occurs within 18 inches of the surface; in Onamia it is deeper. These soils are somewhat droughty. Common agricultural crops grown are corn (in southerly areas), oats, and hay. Where not used for agriculture forest growth is common. Jack pine is most common on the Chetek, and aspen or scrub red oak on the Onamia.

54. Menahga. This is a level to rolling area. This light colored droughty soil has formed from noncalcareous medium textured outwash sand. Agriculture is not important on this soil. Most areas support a stand of jack pine trees. A considerable amount of jack pine is used for pulpwood and lumber.

55. Menahga-Marquette. This is a level to rolling area. These light colored soils are droughty. Menahga has formed from noncalcareous fine to medium outwash sand. Marquette has formed in a medium textured material overlying calcareous gravel within 18 inches of the surface. Agriculture is of only minor importance. Jack pine is the most common tree species in the area, considerable amounts are cut for pulpwood and lumber.

56. Omega-Cloquet. This is a nearly level area. These soils are droughty and are mostly used for forest production. Omega has formed from noncalcareous red fine and medium sand outwash. Cloquet has formed from sandy loam or loam material overlying noncalcareous gravelly glacial drift. Agriculture is not important on these soils. Jack pine and some aspen occur in most areas.

57 Zimmerman-Isanti-Peat. This is a nearly level to gently rolling area. The peat organic soils are intermingled with the mineral soils formed from outwash or windblown fine sand. Zimmerman is moderately dark colored and excessively drained, Isanti is dark colored and very poorly drained. Some general farming takes place in this region. Common crops are corn, soybeans, oats, and hay. Some truck and horticultural crops are grown.

Availability of Detailed Soil Surveys

The soil survey program is a cooperative effort between the University of Minnesota Agricultural Experiment Station's Department of Soil Science, and the U. S. Department of Agriculture Soil Conservation Service.

Detailed soil surveys are available for most major soil areas of Minnesota. Soil associations shown on the map in this report and county soil surveys that are available in each association are listed in the adjoining table. Detailed information on these soil associations or county surveys is available on request from the Department of Soil Science, Institute of Agriculture, St. Paul 1, Minnesota. Free copies of the maps and reports also may be obtained from a Minnesota representative in Congress (while his supply lasts) or from the Office of Information, U. S. Department of Agriculture, Washington 25, D.C.

Copies may be purchased for a fee from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. Some early reports now out of print may be found in libraries throughout the state.

Estimated acreage of each soil association, the percent of Minnesota it occupies, and available county soil surveys for each soil association.

Acres	Percent	Soil association	County and date of survey
2,089,200	4.08	Silty Forest and Prairie Soils of Southeastern Minnesota	
250,900	0.49	1. Fayette-Dubuque	Fillmore (1958) Winona (1941 Wabasha (1964)
1,269,900	2.48	2. Fayette-Dubuque-Rough Land	
368,700	0.72	3. Fayette-Tama	
199,700	0.39	4. Tama-Downs	
1,259,600	2.46	Medium Textured Prairie and Prairie Border Soils of Southeastern Minnesota	
276,500	0.54	5. Kasson-Skyberg-Floyd	Mower (1956) Dodge (1961) Dakota (1960)
599,100	1.17	6. Ostrander-Kenyon-Floyd	
384,000	0.75	7. Racine-Ostrander	
910,000	1.78	Coarse to Fine Textured Forest Soils of East-Central Minnesota	
169,000	0.33	8. Dalbo-Brickton	Isanti (1958) Kanabec (1933)
619,600	1.21	9. Hayden	Isanti (1958) Wright (1965)
122,900	0.24	10. Hayden-Burnsville	Wright (1965) Scott (1959)
2,652,400	5.18	Medium to Fine Textured Prairie Border Soils of Central Minnesota	
184,300	0.36	11. Hayden-Kilkenny-Lester	Scott (1959) Le Sueur (1954) Wright (1965) Waseca (1965)
2,468,100	4.82	12. Lester-LeSueur-Glencoe	
4,525,440	10.41	Medium to Fine Textured Prairie Soils of South-Central Minnesota	
3,748,240	7.32	13. Clarion-Nicollet-Webster	Faribault (1957) Nicollet (1958) Brown (1951)
747,600	1.46	14. Clarion-Storden	
20,500	0.04	15. Ihlen-Rock Outcrop	
809,100	1.59	16. Truman-Marna	
788,600	1.54	Silty Prairie Soils of Southwestern Minnesota	
76,800	0.15	17. Ihlen-Moody	Rock (1950)
599,100	1.17	18. Kranzburg-Vienna-Moody	
112,700	0.22	19. Moody-Crofton	
5,801,600	11.33	Medium to Fine Textured Prairie and Prairie Border Soils of Western Minnesota	
3,236,200	6.32	20. Barnes-Aastad-Flom	Stevens (1966) Lincoln (1966)
1,218,700	2.38	21. Barnes-Buse-Pierce	
988,300	1.93	22. Waukon-Barnes	
358,400	0.70	23. Winger-McIntosh	
4,367,920	8.52	Medium Textured Forest Soils of North-Central Minnesota	
4,367,920	8.52	24. Nebish-Rockwood	None
3,338,600	6.52	Coarse to Medium Textured Forest Soils of East-Central Minnesota	
143,400	0.28	25. Bock-Adolph-Peat	None
1,362,100	2.66	26. Flak-Brainerd-Nokay	Crow Wing (1965)
81,900	0.16	27. Kingsley-Chetek	Dakota (1960)
332,800	0.65	28. Milaca-Chetek	Pine (1935) Kanabec (1933) Mille Lacs (1927)
1,213,600	2,37	29. Milaca-Mora-Bock	
204,800	0.40	30. Santiago-Freeon-Freer	
1,080,500	2.11	Fine Textured Forest Soils of East-Central Minnesota	
1,034,400	2.02	31. Hibbing-Zim	Crow Wing (1965)
46,100	0.09	32. Ontonagon-Berglund	None
5,944,900	11.61	Coarse to Fine Textured Prairie Soils and Organic Soils of Glacial Lake Plains	
547,900	1.07	33. Bearden-Glyndon	Red River Valley Area (1933) Roseau (1936)
1,536,200	3.00	34. Fargo	
706,600	1.38	35. Grimstad	
1,172,600	2.29	36. Rocksbury-Fargo	
681,000	1.33	37. Rocksbury-Peat	
1,300,600	2.54	38. Ulen-Sioux-Grimstad	
6,661,800	13.01	Coarse to Fine Textured Forest Soils and Organic Soils of Glacial Lake Plains	
158,700	0.31	39. Hiwood	
1,044,600	2.04	40. Hiwood-Peat	Roseau (1936)
1,797,300	3.51	41. Indus-Taylor-Peat	
1,822,900	3.56	42. Peat	
1,121,400	2.19	43. Peat-Swatara-Spooner	
378,900	0.74	44. Redby-Peat	
338,000	0.66	45. Spooner-Peat	
4,654,600	9.09	Coarse to Fine Textured Forest Soils and Rock Outcrops of Northeastern Minnesota	
2,437,400	4.76	46. Ahmeck-Rock Outcrops	None
1,208,500	2.36	47. Cloquet-Taylor-Rock Outcrops	
404,500	0.79	48. Ontonagon-Rock Outcrops	
604,200	1.18	49. Rough Rock Outcrop Areas	
2,765,100	5.40	Coarse to Medium Textured Prairie Soils Formed from Glacial Outwash	
2,365,700	4.62	50. Estherville-Wadena-Hubbard	Nicollet (1958) Brown (1951)
399,400	0.78	51. Waukegan-Dakota	Dakota (1960) Scott (1959)
5,061,000	6.96	Coarse to Medium Textured Forest Soils Formed from Glacial Outwash	
189,500	0.37	52. Chetek-Menahga	Crow Wing (1965)
522,300	1.02	53. Chetek-Onamia	
1,003,600	1.96	54. Menahga	
911,500	1.78	55. Menahga-Marquette	
163,900	0.32	56. Omega-Cloquet	Pine (1935)
573,500	1.12	57. Zimmerman-Isanti-Peat	Isanti (1958) Sherburne (1966)
199,700	0.39	Mines and Dumps	

Cooperative extension work in agriculture and home economics, University of Minnesota, Agricultural Extension Service and U.S. Department of Agriculture cooperating, Skuli Rutford, director. Published in furtherance of Agricultural Extension Acts of May 8 and June 30, 1914. 50M—6-63